produced, among other charts, the rainfall of the world in four seasons by Dr. A. Supan, and also twelve monthly charts by Dr. A. J. Herbertson. Both of these sets of charts are, however, on the Mercator projection and on too small a scale to be easily consulted. Subsequently, Dr. Herbertson has been able to slightly amend his original charts, which seem to have belonged to his dissertation for the attainment of the degree of Ph. D., at the University of Freiburg in Breisgau, in 1898. This dissertation is entitled The Monthly Rainfall over the Land Surface of the Globe, and has been printed in English. A new edition of this dissertation to accompany a new set of charts, twelve monthly and one annual, on a much larger scale, is entitled The Distribution of Rainfall over the Land, London, 1901, and is published, apparently, as a separate pamphlet, by the Royal Geographical Society. In the text Dr. Herbertson gives numerical data when it is not easily accessible elsewhere, but does not reprint that given in his lists of data and bibliography or in Dr. Supan's Distribution of Precipitation, published in 1898 as one of the Ergänzungshefte of Petermann's Mittheilungen. The text of the two pamphlets differs principally in that the second pamphlet contains, on pages 53–56, certain remarks on the annual and seasonal distribution that do not occur in the original dissertation.

In general this memoir gives thirteen maps of the globe on Lambert's equal area azimuthal projection for each month and for the year the distribution of rainfall over all the land surfaces where observations have been made. Nothing is said about rainfall on the ocean except to refer to the new edition of the memoir by Mr. W. G. Black, published by the Geographical Society of Manchester, Edinburgh, 1899.

In his general remarks Dr. Herbertson says:

There are seven well-marked bands of high and low rainfall girdling the earth, viz: (1) The subequatorial wet belt; (2), (3) the subtropical dry belts; (4), (5) the temperate wet belts; (6), (7) the polar dry belts. These hyetal belts move north and south during the year with the sun. In equatorial regions there are two wet and two dry seasons every year; most rain falls when the sun is highest, at noon, except on the west coasts of temperate lands. Rain can fall steadily and in considerable quantities only when there is a steady cooling of the atmosphere, as when (1) the air steadily moves from warmer to cooler regions, or (2) when it has an ascending convectional movement, as in equatorial regions when the sun is overhead at noon, or (3) when the convectional movement is in connection with the complicated atmospheric disturbances called cyclones, or (4) when a range of mountains deflects the surface winds into higher regions. The ascending convectional movements, 2, 3, and 4, are the most important sources of rains, and occur when the sun is highest in the heavens. In general, the maximum rainfall occurs when the sun is nearest the zenith at noon, viz, (1) in summer, for places beyond the Tropics; (2) about the time of the equinoxes, for places at the equator; and (3) at intermediate times, at other intertropical stations. The winter cyclones of the temperate belt can not penetrate far into the interior of the continents, where a great high-pressure system exists; hence the rains may be heavy on the coasts, but do not spread far inland. On the other hand, in the summer the low-pressure areas over the continents are the goal of steady winds, slowly inflowing from all sides. The summer rains are in part the outcome of the greater capacity of the atmosphere for vapor, since this capacity increases more rapidly than the temperature, so that the same amount of cooling yields a greater rainfall from air that is saturated at high temperatures than at low temperatures. Much summer rain has its origin in local evaporation. The water must be replaced if the rainfall is to continue. It can only come from the oceans. Hence a slow current of vapor must steadily flow into the region of summer rains. The normal trade winds are usually dry and are passing from regions of low temperature to those of high temperature. The trades do not cause any rain as long as they are not forced upward. Thus the flat llanos of South America are dry while the northeast trades rule over them, and in winter these trade winds affect only a narrow strip of mountainous coast land; but in summer, when the trade winds are sucked in toward a well-developed low pressure, they become the source of the heavy convectional rains, as in the case of the Asiatic monsoon rain. The influence of ocean currents on rainfall is indirect, through the temperature of the air. The most interesting example of this is the low rainfall on the tropical west coasts of the continent.

The effects of mountain barriers are seen in the Monthly Rainfall Maps. The line of maximum elevation is not necessarily the line of heaviest rain; the latter may lie on the leeward slope of the mountains or at some distance from the edge of a plateau. The air may continue to rise for some distance as it moves beyond the ridge, and the maximum precipitation may occur even beyond this line, and not on the windward slope.

Herbertson's monthly and annual charts supply a long felt want and will be made the foundation of many studies. They came in very opportunely in connection with the Editor's recent exposition of the physical basis of long-range seasonal forecasts of rainfall.

THE STORMS OF THE HAWAIIAN ISLANDS.

Under date of March 8, Mr. Curtis J. Lyons writes that an examination of the United States daily weather maps shows that—

The connection between our November storms and the lows that appeared on the Oregon and Washington coast is, I think, very apparent.

The storm that prevailed here from February 5 to 14 very evidently came up from south-southwest, as we had a southeast to south-southeast gale for two or three days, previous to the southwest winds—this is unusual. The barometer fell to 29.48, the lowest for twenty years.

THE RAINFALL AND EVAPORATION OF GREAT SALT LAKE.

On a previous page we publish a paper by Mr. Simon F. Mackie dealing with the changes of level and the total rainfall. This question is one that has been discussed in previous numbers of the MONTHLY WEATHER REVIEW, but will always interest meteorologists and geologists. Any solution of the question of rainfall, evaporation, inflow, and outflow that applies to Great Salt Lake, will doubtless also apply to many other lakes throughout the world. In general it must be remembered that the rainfall records for one or two stations in the neighborhood of the lake, or within its watershed, may not be perfectly representative of the whole watershed. The following table is furnished to the Editor by Prof. A. J. Henry as containing all the data in the archives of the Weather Bureau from stations in the watershed of the Great Salt Lake.

Rainfall in inches in Salt Lake watershed.

Year.	Salt Lake City.	Ogden.	Coalville.	Provo.	Logan.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1874	14.67	....	....	....	....
1875	23.64	20.69	21.02	....	....
1876	21.28	14.80	14.20*	....	....
1777	16.35	13.95	11.75	....	....
1878	19.75	15.11	10.71	....	....
1879	13.11	12.35	....	....	....
1880	10.94	10.24	....	....	....
1881	16.93	10.13*	....	....	....
1882	15.98	9.07	....	....	....
1883	14.24	10.98	....	....	....
1884	17.52	19.49	....	....	....
1885	19.69	19.40	....	....	....
1886	18.89	12.60	....	....	....
1887	11.66	9.14	....	....	....
1888	13.62	12.03	....	....	....
1889	18.46	16.91	....	....	....
1890	10.83	18.61	....	....	....
1891	15.82	23.11	....	....	....
1892	14.08	14.20	....	....	....
1893	17.35	16.97	....	....	14.51
1894	15.27	16.04	....	10.21	14.36
1895	11.95	....	....	10.57	13.51
1896	18.42	13.95	....	....	16.15
1897	16.74	....	....	....	17.45
1898	16.09	....	....	13.95	13.18
1899	....	13.53	....	....	12.60
1900	....	....	....	....	15.06

* Somewhat doubtful.

By plotting the stations it will be seen, as Professor Henry states:

That the rainfall record at Salt Lake City may be taken to represent the average rainfall over a belt of country 20 to 30 miles wide, but not wider, on the eastern shore of the lake. As one goes eastward the rainfall appears to diminish slightly. We have no record of the rainfall on the higher mountain ranges directly east of Salt Lake City.

To this we must add that the precipitation on these mountains is undoubtedly larger than in the lowlands. Moreover, there seems to be no record whatever of the amount of rain over the western portion of the lake and its watershed. For accurate and satisfactory study one ought to have river gagings sufficient to determine within 5 per cent the monthly and annual inflow into the lake on all sides instead of the few rainfall measurements that at present so imperfectly represent the rivers and the seepage.

With regard to the evaporation we can do no better than to state that inasmuch as it depends upon the temperature of the lake surface, on the sunshine and cloudiness, on the dryness of the air, and especially on the total wind movement, which latter depends upon both velocity and duration, it must be evident that it is impossible to make an accurate calculation of its total amount unless we have continuous records that are not now available. The best we can do is to make a general application of the investigations by Prof. Thomas Russell. See his Depth of Evaporation in the United States, MONTHLY WEATHER REVIEW, September, 1888, pages 235–239. In this memoir he shows that for Salt Lake City during the year July, 1887 to June, 1888, the depth of evaporation, in inches, from a surface of fresh water kept in a thermometer shelter at the Signal Service station would have been:

	Inches.		Inches.
1888, January	1.8	1887, August	10.7
February	2.7	September	9.6
March	3.6	October	6 5
April	7.2	November	5.0
May	6.9	December	2.3
June	8.9		
1887, July	9.2	Total annual	74.4

What the evaporation from a surface of salt water would have been we do not know.

In the Annual Report of the Chief Signal Officer for 1889, pages 159–172, Professor Russell gives an elaborate study of the rainfall and outflow in the Mississippi Valley showing that in general when the rainfall is heavy a much greater part of it reaches the river than when it is light; the ratio varies from $\frac{1}{2}$ to $\frac{1}{10}$.

It is hardly likely that the sum total of the influences of sunshine and cloudiness, dryness, and wind as affecting evaporation can be combined with the effect of rainfall and run off so as to be expressed by any simple function of the rainfall. But evidently we need more rainfall stations and a more complete record of the seepage through the soil and of the flow of streams into Salt Lake.

HARVARD'S METEOROLOGICAL STATIONS.

In a recent number of the MONTHLY WEATHER REVIEW we have described the important series of meteorological stations maintained during several years past in South America by the astronomical observatory of Harvard College, and extending from the Pacific Ocean to the Desert of Atacama and beyond. We regret to learn that this important work is now discontinued. However, undoubtedly, extensive additions to our knowledge will appear when the results are reduced and published. The following quotation is taken from the fifty-fifth annual report of Prof. E. C. Pickering, director of the observatory:

> Meteorological observing stations have been maintained during the year at Mollendo, altitude 100 feet; La Joya, 4,150; Arequipa, 8,060; Alto de los Hiesos, 13,300; Mont Blanc, 15,600; El Misti, 19,200; Vincocaya, 14,600, and Puno, 12,500. Great difficulty has been found in carrying on the observations at the lofty mountain stations. Whenever possible all the stations have been visited once a month by a member of the staff of the Arequipa station, and the self-recording and other instruments compared with various standard instruments, including a mercurial barometer and a psychrometer. Instruments designed and constructed by Señor Muniz, for recording automatically the velocity and direction of the wind, have been placed at all the stations, except those already provided with anemometers. The meteorograph which failed to give satisfactory results at the summit of El Misti has been placed at the Mont Blanc station, and has given records for about one-half of the time. The observations at these different stations have now been continued in many cases for eight or ten years. At such stations, where from the necessities of the case, the observers are generally men of limited education and experience, observations of the greatest accuracy can not be expected, except by maintaining trained observers at greatly increased expense. It is believed that the personal observations which have been secured, and the results of the records of the self-registering instruments, will furnish valuable information to meteorologists concerning a region about which little was previously known. Taking into consideration the striking uniformity of conditions which prevail in different years in this region, it is probable that additional observations would not greatly increase our knowledge. It has been decided, therefore, to suspend, at the end of the year 1900, the meteorological observations of all the stations except those at Arequipa.

REFLECTION BY CLOUDS OF LIGHT FROM A DISTANT FIRE.

Mr. T. S. Outram, Section Director at Minneapolis, Minn., reports that on the evening of March 14, between 9 and 10 p. m.:

> A vertical shaft of light of a dull red color, situated about 15° from the zenith was observed bearing about 60° east of north. At that time there was a very brilliant conflagration at the distance of a mile or more in that direction. When first seen the sky for some distance around the shaft of light was partly overcast with fine cirro-cumulus clouds, and above these thin cirro-stratus clouds. The phenomenon was on the higher clouds and was distinctly seen through the ruddy reflection on the cirro-cumulus clouds. Later the cirro-cumuli passed off entirely, leaving the cirro-stratus, which were so thin that a few stars could be seen near the zenith. By 9:30 p. m. the sky was apparently clear, but at that time the shaft of light was so faint that it could hardly be seen. The greatest length of the shaft was equal to the distance between the two outer stars of the bowl of the Great Dipper. During the whole time the wind was north, blowing from 20 to 25 miles per hour.

The above description shows that we have here to do with the reflection of a distant light from the horizontal flat under surfaces of the crystals of snow that usually form cirrus clouds. When the sun is in a proper position near the horizon its rays are similarly reflected and give rise to vertical beams of light that usually form an integral part of solar halos. Of course, these crystals could not maintain their surfaces horizontal unless the air were very quiet, allowing them to settle downward very slowly.

HISTORY OF METEOROLOGY IN BELGIUM.

For sixty-seven years the Royal Observatory of Belgium has regularly published its Annuaire de l'Observatoire Royale, devoted to astronomy and meteorology, but, beginning with the year 1901, it will publish two separate works, viz, the Annuaire Astronomique and the Annuaire Météorologique. These small 16mo volumes will correspond to the quartos, viz, the Annales Astronomiques and the Annales Météorologiques, which began to be published separately in 1881. Magnetic phenomena will be published in connection with the Annuaire Astronomique, since the astronomical director, Dr. L. Niesten, has especially interested himself in this subject and is preparing to continue and publish the magnetic survey carried out by Houzeau and Estourgies in 1878–1882. A monthly magnetic bulletin in 16mo will be published, giving a résumé of the results of the self-registering instruments at the observatory, which is located at Uccle, near Brussels.

The Annuaire Météorologique for 1901 contains, among other interesting articles, a review of the history of meteor-